Director of Central Intelligence Postdoctoral Research Fellowship Program

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1. INTRODUCTION

The Director of Central Intelligence (DCI) has established a Postdoctoral Research Fellowship Program within the CIA's Directorate of Science and Technologies (DS&T), Chief Scientist Staff. The DCI Postdoctoral Research Fellowship Program was created in response to the Intelligence Community (IC) requirement to address long-term research and technology needs that will meet the goals and mission of the IC. The Postdoctoral Research Fellowship Program will provide the IC an outreach opportunity into centers of expertise in academia and national laboratories and help to engage fully with experts outside of the Intelligence Community. As the role of science and technology becomes an increasingly critical driver of global developments, the DCI Postdoctoral Research Fellowship Program will focus on research in leading edge technologies supporting broad Intelligence Community technology needs.

The National Imagery and Mapping Agency's (NIMA's) InnoVision Directorate will act as an executive agent for the university-based segment of the DCI Postdoctoral Research Fellowship Program. NIMA's role as executive agent includes posting this Broad Agency Announcement, managing the proposal review process and using its grant authority to make awards in the program.

2. GENERAL INFORMATION

The Director of Central Intelligence (DCI) and the DS&T's Chief Scientist announce a Fiscal Year 2003 competition for the DCI Postdoctoral Research Fellowship Program.

The mission of the DCI Postdoctoral Research Fellowship Program is to establish long-term relationships and mentoring of postdoctoral researchers and to provide research institutes with an understanding of the Intelligence Community's research requirements. The program will foster partnerships with postdoctoral researchers as they move into career positions and provide innovative solutions to critical Intelligence Community problems.

The primary goals of this program are to:

- Build positive relationships with postdoctoral researchers presently and as they move into career positions;
- Establish one to three year alliances with Postdoctoral Fellows through competitive grants with universities, private research institutes and national laboratories;
- Provide the Intelligence Community access to advanced research in science and technology through a postdoctoral research program;
- Identify new sources of research applicable to the Intelligence Community's mission

and solve critical Intelligence Community problems in innovative ways; and

- Provide a pool of researchers capable of supporting future Intelligence Community needs.

Through this competition, the Chief Scientist (CS) expects to make awards in specific research topics. All awards will be based on merit competition. Depending on the quantity and quality of proposals received, the CS may not make any award(s) under a particular research topic. In the event more funds become available additional awards maybe made at a later date based on initial evaluation results. Typically each award will be:

- For a basic period of one year (funded incrementally), with a potential option for a second and third year, and

- For the amount of $100,000 per year/per grant.

This DCI Postdoctoral Research Fellowship Program competition is specifically for the research topics described in paragraph 8. Offerors are advised to read this announcement carefully. It explains the program research needs upon which the topics are based and the terms and conditions of this competition.

3. AREAS OF INTEREST

In paragraph 8, this BAA describes twenty-two (22) research areas, comprising some of the Intelligence Community's most current technology interests. These descriptions provide offerors with a frame of reference. The DCI encourages innovative ideas that address these interests. Offerors are urged to consider the research issues posed and, as appropriate, to contact our research topic chiefs to discuss potential efforts. Inquiries are welcome. Note that while technical contacts are listed for a topic, proposals must be submitted only to the addressees shown in paragraph 5.2.

4. CONDITIONS

The DCI expects that DCI Postdoctoral Research Fellowship Program projects will promote application of research primarily for intelligence purposes. The first phase of this competition has been completed. An internal program call was placed – at the National Foreign Intelligence Program (NFIP) agencies: CIA, NIMA, NRO, NSA and DIA (including NGIC, NAIC, AFMIC, CMO and others) – for federal NFIP employees interested in making a commitment to serve as an Intelligence Community advisor (mentor) for a minimum of two years. Intelligence Community advisors submitted their resumes as well as proposed research topics that would help to draw highly qualified Postdoctoral Fellows for Intelligence Community-related research. These research topics are listed in paragraph 8.

With completion of the first phase, the call in this announcement is seeking qualified postdoctoral research investigators interested in being funded to support research in the specified topical areas and to support interactions with the Intelligence Community advisors.

Potential Fellows must be associated with an accredited U.S. university or college. **Each Postdoctoral Fellow must be a U.S. citizen.** The principal investigator / university mentor, is **NOT** required to be an U.S. Citizen.

5. SUBMISSION HIGHLIGHTS

The Government will evaluate all proposals submitted under the terms and conditions of this BAA. Government-paid consultants or subject matter experts may be involved in the evaluation and selection processes.

5.1. General

The CS, through NIMA as his executive agent, intends to award with FY03 funding. To be considered and evaluated the Government must receive the full proposal by the due time and date identified in paragraph 9.

NIMA will send the offeror an acknowledgment of receipt of the submission, and will follow-up later with a notification letter announcing whether the proposal is being recommended for an award. Acknowledgment and notification will be sent to the principal investigator via e-mail, according to the schedule in paragraph 9, with a copy to the appropriate university administrative office.

Proposals will be evaluated against criteria described in paragraph 6.1. The estimated grant start date identified in paragraph 9 should be used for budget and proposal purposes. **You may, however, request a later start date and may therefore develop your budget based on your proposed start date.**

5.2. Submission

Proposals shall be formatted as one .doc file (or "zipped".doc file) of a size not to exceed 1.95 Megabytes in total. The Government's mail servers will not accept files of a greater size. The proposal shall reference BAA Number NMA 501-03-BAA-0001. Proposals shall be submitted electronically by e-mail and simultaneously to MoorJA@nima.mil and mpf-it@ticomeast.com.

5.3. Content

Proposals must be complete and self-contained to qualify for review. Proposals

shall be prepared single-spaced in 12-point Times New Roman font, with at least one-inch margins on top, bottom and sides, on 8_" by 11" paper.

The Intelligence Community is concerned with research in specific areas of science and engineering. For this reason, all proposals must adequately describe the technical objectives and approaches, support of principal investigator and Postdoctoral Fellow, and expenditures for equipment, all of which will be evaluated by qualified reviewers per paragraph 6.2. Separate attachments, such as institutional brochures or reprints that are not germane to the proposal, are discouraged.

The proposal shall include all of the following items.

5.3.1. Cover Page

The cover page shall include the BAA number (**NMA501-03-BAA-0001**), proposal title, and topic or research area of interest. The cover page must also indicate the name, phone number, fax number, postal address, and e-mail address of both the principal investigator AND an appropriate official in the university's research administration office.

5.3.2. Project Description

The project description portion of the proposal shall be limited to three pages and shall:

A. Describe the proposed research objectives and approach to be undertaken. State the objectives and approach and the relationship to state-of-knowledge in the field and to similar work in progress. Include appropriate literature citations and prior work. Discuss the nature of expected results.

B. Describe the expected outcomes and relevance to the Intelligence Community research need.

C. Identify other parties to whom the proposal has been/will be sent.

5.3.3. Resume

The Resume shall be limited to two (2) pages each and shall provide the credentials of the principal investigator, demonstrating why the offeror is qualified to do the work proposed. If a Postdoctoral Fellow has been identified, an additional resume, two (2) pages in length, may also be included.

5.3.4. Cost

Beginning on a new page, the financial portion of the proposal should contain cost estimates in sufficient detail for meaningful review. The annual cost must be no greater than $100,000. At least 50% of this cost should be allocated for direct support of one full-time Postdoctoral Fellow, including salary and fringe benefits. The remaining funds can be allocated to a fraction of the principal investigator's time, unique equipment needed to conduct the proposed research, other direct costs and university overhead. For proposal purposes, use the later of the estimated award start date per paragraph 9 or the offeror's proposed start date. Exceptions to the above-recommended allocation will need to be approved by the Chief Scientist. The cost proposal must include the total cost of the project, as well as a breakdown of the amounts by source of funding (e.g., funds requested from the DCI Postdoctoral Research Fellowship Program, and/or institutional funds to be provided as cost sharing). The costs should be broken down for each year of the program and shown by three distinct totals: a total for the basic year and a total for each of the optional follow-on years. Although expected to be short, there is no page limit for the cost section of the proposal. Cost elements should include, but are not limited to:

A. Time being charged to the project by the principal investigator and Postdoctoral Fellow, and their commensurate salaries and benefits.

B. Costs of equipment based on most recent quotations and broken down in sufficient detail for evaluation (equipment costs should be budgeted primarily during the first year). Allowable equipment will ordinarily be limited to research equipment and apparatus not already available for the conduct of the work. General-purpose equipment, such as a personal computer, is not eligible for support unless primarily used in the actual conduct of the proposed scientific research.

C. Travel costs and time, and the relevance to stated objectives. This shall include a breakdown of the name and number of travelers, location and duration; and estimated costs for transportation, rental car and per-diem. This shall also include travel for the required attendance at the annual DCI Postdoctoral Research Fellowship Program colloquium in the spring of each year. The colloquium is held in the Washington D.C. area.

D. Other direct costs such as materials and supplies; publication, documentation and dissemination; computer services; communication costs not included in overhead; or others (identify). These costs shall

include at least one published article per year in the Journal of Intelligence Community Research and Development (JICRD). This published article will need to be coordinated, vetted and submitted through the IC Advisor.

E. Indirect costs.

5.3.5. Certifications

By signing and submitting any proposal under this BAA, the offeror is providing the:

A. Certification at Appendix A to 32 CFR Part 25 regarding debarment, suspension, and other responsibility matters;

B. Certification at Appendix C to 32 CFR Part 25 regarding drug-free workplace requirements; and

C. Certification at Appendix A to 32 CFR Part 28 regarding lobbying.

These certifications are located in Parts 25 and 28 of the DoD Grant and Agreement Regulation (DoDGARs), D0D 3210.6-R. This document is available electronically, under the heading "publications", at the following Internet site: http://www.dtic.mil/whs/directives/.

The person who is authorized to provide these certifications should sign the proposal. Proposals submitted without signatures shall require a separate execution of the certifications. Also, it will be necessary for either the Dean or Provost at the University to acknowledge that they are receiving CIA Funds.

6. EVALUATION CRITERIA AND SELECTION PROCESS

6.1. Criteria

The evaluation criteria are:

A. The qualifications of the principal investigator and Postdoctoral Fellow;

B. Relevance and potential contributions of the research to the Intelligence Community's missions; and

C. Scientific and technical merits of the proposed research.

D. The realism and reasonableness of cost, including proposed cost sharing.

Evaluation of cost shall be based on cost realism as it relates to the Government's degree of confidence in the offeror's ability to perform the proposed work at the proposed cost.

6.2. Proposal Evaluation Process

The Intelligence Community Advisors will independently review the proposals, evaluating them in accordance with all the evaluation criteria of paragraph 6.1 of this document, and completing a set of Evaluation Worksheets for each proposal. Proposals will be grouped together by specific research area. One expert team will evaluate all proposals in the same group. Out of all the proposals evaluated in the same group, the expert team will prioritize and recommend one or more proposals as they determine to be "selectable." A composite of criteria A and B is significantly more important than criteria C and D. Criterion C is significantly more important than criterion D.

Next, all the recommended selectable proposals will be discussed by an Evaluation Panel consisting of the five NFIP agency points of contact, the NIMA executive agent and the DCI Postdoctoral Research Fellowship Program Manager. The panel anticipates to award two grants to each NFIP agency (CIA, NIMA, NRO, NSA, DIA). The panel will convene and will consider the overall contribution of each 'selectable' proposal as reflected by the numerical score, the potential contribution to the advancement of the targeted technical topic(s), the amount of similar or related research already underway on a given topic and the amount of available funding. This step brings a cross-discipline balance to the selection process, reconciles recommendations about proposals spanning more than one technical area, and allows for strategic consideration of the diversity of proposals across the topic areas. While it is the panel's intent to make two awards to each of the five NFIP agencies, the final outcome may not reflect this intent. In summary, the combination of 'selectable' proposals that most effectively advances NFIP's academic research program will be recommended for award. The number of awards made is dependent upon the amount of available funding. If added funding becomes available from within the community or from other U.S. Government agencies, the program may choose to make additional awards under the terms of this BAA from the remaining selectable proposals. The sponsoring organization will be free to support any 'selectable' proposal(s) that addresses the research interests of that organization.

The list of proposals recommended for award, along with a description and results of the evaluation process, will be forwarded to the Director of Intelligence Technology Innovation Center (ITIC) for approval. When approved, the award list will be forwarded to the Contracting Officer for award action, to include as necessary, cost analysis and contract negotiation. Awards will be made upon successful negotiation.

7. AWARDS

Awards will be made for one year with two one-year options. The Government expects to exercise the first year option assuming quality research is ongoing. Second year option will be the exception, rather than the rule. The awards will be incremental funded at funding levels no greater than $100,000 per year, per award/option period.

Notification announcing whether or not the offeror's proposal is being recommended for an award will be e-mailed directly to the principal investigator. Awards are expected to be in place by the proposed start date or the start date identified in paragraph 9, whichever is later.

Once a proposal is selected for award, one of two scenarios will be executed:

A. If a postdoctoral candidate is already identified and prepared to begin the proposed research, 100% of the first year's award funding could be provided by the start date.

B. If a qualified postdoctoral candidate must be sought, $10,000 of the award amount will be provided initially, with the remaining first year's funding provided when the qualified candidate is identified and selected by the university.

8. SPECIFIC RESEARCH TOPICS FOR FY03 DCI POSTDOCTORAL RESEARCH FELLOWSHIP PROGRAM

The following 22 topics represent the Intelligence Community's research interests particularly suited this year for investment. An award in any topical area will be made only if a sufficiently meritorious proposal is received. The CS reserves the right to allocate available funds among topics based on the quality of the responses and priorities. Following are the titles of the proposed research topics with the agency having primary interest in each topic shown in parentheses after the title. A detailed description of each topic with Point of Contact (POC) data is presented in following paragraphs.

1. Micro- and Nano-scale High Performance Rechargeable Battery Technology (CIA)
2. Software Radio Research (CIA)
3. Lithium-Ion Battery Technology (CIA)
4. 3-D Face Modeling and Display (CIA)
5. Cold Atom Optics (NIMA)
6. Data analysis from Passive Hyperspectral and LIDAR sensors (NIMA)

7. Structure and Dynamics of Complex Networks (NIMA)
8. Unconstrained, goal-based visual scene analysis (NIMA)
9. Modeling Spatial Spread of Infectious Diseases (DIA)
10. Comparison of Numerical Algorithms for Assessing the Usefulness of Magnetohydrodynamic Flows (DIA)
11. Sensemaking: Improving the Shared Creation of Knowledge (DIA)
12. Investigating Various Empirical and Linguistic Methods in Pursuit of Automated Analysis, Data Mining, Collaboration and Inference Processes (NSA)
13. Color Appearance Models and Improved Visual Analysis (NSA)
14. Separation, Functionalization, and Self-Assembly Chemistry of Carbon Nanotubes (NSA)
15. Earthquake Pre-cursor Propagation Model and Signal Analysis Techniques (NRO)
16. Nano-Electromechanical systems (ITIC)
17. Bio-Nano Electronic Circuitry (ITIC)
18. Multi-User Detection: Algorithm Evaluation (ITIC)
19. Smart Materials for Components of Mobile Robots (ITIC)
20. Terahertz Imaging (ITIC)
21. Probabilistic Evidence Marshalling (NRO)
22. Improving the Security of Future Biometric Systems (Dr Andy Kirby, 703-874-1023) (ITIC)

8.1. Micro- and Nano-scale High Performance Rechargeable Battery Technology

POC: Dr. Enoch Wang, 703-874-0726 (CIA)

The development and implementation of distributed sensing and communications technology, as well as other portable electronics of military and intelligence interests, has to a large extent been limited by the power source. Proposals are sought for the development of new battery designs and fabrication approaches that can provide reliable

rechargeable power under extreme conditions in a wide variety of form factors and size scales. The proposed technology should be capable of achieving performance metrics in excess of state-of-the-art lithium ion technology, with energy densities exceeding 500 W/liter (200 W/kg) at power densities exceeding 2000 W/liter (1000 W/kg) at the device level. The proposed technology should be capable of sustaining more than 1000 deep cycles at temperatures between –40C and +70C. Fully solid-state technologies are preferred for reliability and durability. Current understanding of transport rates in available storage materials and electrolytes suggests that micro- and nano-scale structures will be necessary to meet these performance metrics. Fabrication approaches that provide scalability, ease of manufacture, and not limited to thin-film form factors or vacuum environments, are sought. The preferred approaches will provide simplified wet chemical processing with few sequential steps, and allow the ubiquitous application of high performance rechargeable batteries of a wide range of size scales to devices. The size scales of interest range from active footprints and volumes as well as 10 nm x 10 nm and 10^{-5} m^3, up to 1 cm^2 and 1 cm^3.

8.2. Software Radio Research

POC: Dr. David Jackson, 703-874-7511 (CIA)

Software radio technology will play an important role in emerging worldwide wireless communications systems and thus is fundamental to Intelligence Community missions.

The goal of this research topic is to identify, develop and demonstrate technologies for handheld and mobile software radios that improve flexibility while having the highest potential to reduce risk, volume and required source power. Three classes of technologies for research topics are:

1. Components and software algorithms/architectures that improve current radio implementations in order to reduce life cycle cost and development risk.
2. Innovative components or software algorithms and architectures that enable new radio applications.
3. Creation of new technologies that advance the state-of-technology in software radios and that have the potential to impact a broad set of future applications relevant to the Intelligence Community.

Candidate technologies pursued in class 3 above may offer the software radio the features of flexibility and adaptation (at the physical layer) over diverse international wireless waveform and protocol standards.

Advances in software radio technology will involve improved performance in

related technology domains as well as advancements of knowledge in core software radio disciplines (i.e., digital communications, digital signal processing algorithms, general-purpose and digital-signal processors, distributed processing, and radio transceiver circuit theory). High-priority software radio technology domains for the Intelligence Community include:

- High-density packaging processes
- Power-efficient analog-to-digital converters
- General-purpose and digital-signal embedded processors and algorithms
- Direct digital synthesis low-power synthesizers
- Micro-electromechanical-system-enabled transceiver components
- High performance miniaturized filters
- High power-added-efficiency and broadband power amplifiers
- Electrically-tunable or broadband electrically-small antennas

8.3. Lithium-Ion Battery Technology

POC: Ms. Kathryn Steele, 703-874-0759 (CIA)

The Intelligence Community is interested in Lithium-Ion (Li-Ion) battery technology for numerous applications. Li-Ion technology offers the hope of major improvements in cycle life, as well as increased energy and power densities, over currently used technologies. These improvements would allow Intelligence Community systems to have longer lives and/or greater payloads.

In the Li-Ion technology, one major area needing research is the study of the passivating layers formed on the cathode and anode particle surfaces. Approximately 11 percent of the capacity of a cell is lost (irreversible capacity loss) during the first charge-discharge cycles as the Solid Electrolyte Interphases (referred to as SEIs) are formed. Understanding these SEI passivating layers is key to understanding the degradation and self-discharge mechanisms for the Li-Ion electrochemistry. If we are to be able to extend the calendar life and cycle life of Li-Ion cells to what is required for our operations and missions, we must have a clearer understanding of the compositions of the SEIs and what reactions take place there

8.4. 3-D Face Modeling and Display

POC: Mr. Randy Paul, 703-613-8779 (CIA)

Field identification of suspects using 3D-face modeling and display

Existing facial recognition technology from still or video sources is becoming a

viable tool for many law enforcement, security, and counter-terrorist applications despite significant limitations of current technology. The severe errors of the commercialized technology employing automated face recognition has spawned much continuing research aimed at improving the computer's ability to compare images or representations of images and recognize a suspect. In the field, however, officers must identify suspects with human witnesses by describing suspects and showing them pictures, possibly altered, so they can collect information with maximum certainty about the individuals of interest. Automated face recognition is not been applied at this level because it relies on comparison of non-literal extracted representations that would be meaningless to witnesses. The identification of individuals when the recognizer is a person, rather than a computer, requires attention to human perception and the many ways it can be deceived. Because of the limits of human memory there is also an advantage to making identification rapidly and reducing the distractions of unfamiliar surroundings so the option to employ portable computer technology to support the interview of witnesses will otherwise improve communication about persons of interest.

A 3D image of a human face can be created from two images or a video that can be deformed, enhanced, or decorated. This should make it possible to rapidly create a view that is customary to the witness. By changing the angle of view, adding or removing a hat, turban, or facial hair, or applying other techniques the officer can rapidly effect identification that is not as confidently obtained otherwise. Such technology implemented on a PDA will make it possible for the interviewing officer to very rapidly take the technology into the field and eliminate much of the delay associated with traditional techniques.

Research in this area is needed to address measurable recognition rates of humans from synthesized 3D versus 2D images, the usability and human factors of new tools to exploit these results, and the implementation issues of the PDA. The driving goal of research in this area is to improve the ability for an officer in the field to support their discussions with witnesses and suspects with image technology that rapidly improves their communication and leads to more certain identification.

8.5. Cold Atom Optics

POC: Mr. Steve Malys, 301-227-7452 (NIMA)

The physics discipline of Cold Atom Optics capitalizes on the wave nature of atoms and consists of tasks such as cooling, trapping and manipulating atoms with lasers, magnetic fields and electric fields. This discipline is an active area of basic research. A small amount of applied research at several U.S. institutions is also underway. Possible practical applications of this discipline include advancements in:

- Guidance, including inertial forces sensors and frequency standards, and
- New classes of sensors and detectors for gravity gradients and magnetic signatures.

A postdoctoral candidate in this discipline will acquire and build skills in several areas that could eventually be applied toward Intelligence Community problems.

8.6. Data analysis from Passive Hyperspectral and LIDAR sensors

POC: Mr. Ernie Reith, 703-262-4566 (NIMA)

Modeling and simulation of gaseous releases and/or Development of robust algorithms that can interrogate data collected from passive hyperspectral and LIDAR sensors.

The detection and quantification of gaseous effluent continues to be an area of considerable interest to organizations responsible for industrial monitoring. Research efforts to remotely monitor these facilities include passive and active detection systems. The Community needs to better understand the tradeoffs between these two sensing technologies and the algorithms associated with the exploitation of data collected from these devices.

There are numerous theoretical and practical issues to be addressed in the design of both detection sensors and algorithms used to exploit the acquired data. Modeling and simulation of gaseous releases can be used to demonstrate detection, identification, and quantification of effluents as imaged via passive hyperspectral and LIDAR sensors.

A trade study is required to better understand strengths and weaknesses of passive and active sensor systems and to develop the algorithms used to interrogate their data. The trade study will include the development of synthetic scenes representative of a variety of industrial site layouts, plume overlays, and sensor models. Algorithms will be developed and performance evaluated to detect and quantify effluents within the synthetic scenes.

8.7. Structure and Dynamics of Complex Networks

POC: Dr. Paul Salamonowicz, 702-262-4575 (NIMA)

The Intelligence Community is interested in research in the dynamics of how complex networks are organized and how they evolve in time. A central focus is the relationship between structural features of networks and their resulting global dynamics, in particular their complexity. The emerging science of network dynamics focuses on

common structural and dynamical properties that govern the organization and evolution of complex networks across different domains. While scientific understanding of complex networks is still incomplete, some significant progress has been made in the areas of neural networks and the brain, the evolution of the world-wide-web, and the structure of social networks.

In addition, the work will explore how networks adapt to external perturbations (stimuli) by reconfiguring their internal connectivity and information flow. Understanding complex networks is of vital interest to managing, controlling and anticipating information and events at all levels of scale. The goal of this proposal is to provide postdoctoral training and conduct research in this rapidly evolving and interdisciplinary area of science that is of potential relevance to the Intelligence Community. Exposure to this line of work would provide new insights into the functioning of networked organizations, their patterns of communication and interaction, and their robustness and regenerative capability.

8.8. Unconstrained, Goal-based Visual Scene Analysis

POC: Dr. Jeff Kretsch, 703-262-4554 (NIMA)

While computer vision systems have made tremendous progress at understanding visual scenes in constrained environments, currently only biological systems are able to interact with unconstrained environments. The state of understanding of biological vision to date is based on three interacting subsystems: a fast, probable feed-forward computation of a rough gist and layout of the scene; a focus of attention that quickly selects the most interesting objects in the scene; and an object recognition subsystem that analyzes attended objects in detail. The proposed project will further explore the brain mechanisms involved in unconstrained scene understanding, in particular through computational modeling and psychophysical testing (including recording human eye movements) of how specifying a goal (e.g., "look for buildings") may rapidly tune these subsystems so as to allow rapid and efficient extraction of visual information that is relevant to the task.

8.9. Modeling Spatial Spread of Infectious Diseases

POC: Dr. Joy Miller, DVM, Jmiller@AFMIC.detrick.army.mil, 301-619-3895 (DIA)

The DCI Fellowship Program, in conjunction with the Defense Intelligence Agency, Armed Forces Medical Intelligence Center (AFMIC), will provide funding and technical oversight for postgraduate study in infectious disease modeling. AFMIC serves as the sole source of foreign medical intelligence for the US Intelligence Community.

AFMIC's regional intelligence officers monitor infectious disease outbreaks and country-specific baseline levels of disease, and provide assessment of the risk to deployed US forces. The DCI/AFMIC Fellowship Program will focus on developing novel approaches to modeling the spread of militarily relevant diseases, and the impact of human behaviors on disease spread. Behaviors of interest include, but are not limited to, use of vaccination programs, quarantine or contact tracing, and/or the "fear factor" in population movement. Modeling efforts will emphasize infectious diseases that may impact military operations, including those pathogens of known biological warfare (BW) potential.

A variety of reports suggest that state-sponsored and terrorist organizations have pursued the development and acquisition of biological weapons in the past and are continuing to do so today. These pathogens can be transported with relative ease, could command a large terror factor if used, and have the potential—depending upon the agent and attack scenario—to produce mass casualties and/or exact a severe economic toll. When responding to a potential attack, public health officials and policymakers need to make decisions on vaccination, quarantine, and medical therapy. Many of these decisions require an understanding of disease spread in non-homogenous populations in which contact rates with potentially infected individuals will differ. Modeling attack scenarios for military significant infectious diseases, including terrorist use of these agents, assists policymakers in determining which control measures are likely to be effective under different circumstances.

Although many potential pathogens of are interest, smallpox is unique in that the virus has been eradicated globally – the appearance of even a single case of smallpox would be considered a public health emergency. Moreover, smallpox is highly infectious and has a significant mortality rate. The US population is almost entirely susceptible to smallpox, since routine vaccination ended in 1972. Should it appear, smallpox could threaten US military forces in a number of scenarios, including an attack on a military base or deployment, or an attack on a civilian population that "spills over" into susceptible personnel. Many of the existing models for smallpox spread assume homogenous mixing of populations, which may mislead those assessing risk or the impact of control measures. Therefore, novel approaches to modeling the spread of smallpox and other relevant infectious diseases remain critical to determining effective policy to mitigate the potential impact on US citizens at home and abroad.

8.10. Comparison of Numerical Algorithms for Assessing the Usefulness of Magnetohydrodynamic Flows

POC: Mr. Paul Murad, 202-231-2649 (DIA)

Differences in technical approaches may result in technology surprise and, if real,

may alter the U.S. conventional wisdom. Recent comparisons of numerical calculations for Magnetohydrodynamic (MHD) flows indicate that the Russians are predicting lower values for electric and magnetic fields to control fluid dynamic processes within a scramjet engine than predicted by U.S. scientists. The Russians may be using a three-dimensional Navier-Stokes calculation to include turbulence where the electric and magnetic force terms are embedded within the fluid conservation equations. Moreover, fluid source terms appear in some of their descriptions within Maxwell's equations as well.

In contrast, U.S. investigators may use pseudo one-dimensional algorithms and decouple the fluid dynamic conservation equations from Maxwell's equations needed to predict electric and magnetic field strengths, in separate calculations. Subsequent calculations are 'stable' considering the complex numerics. Moreover, agreement within the U.S. R&D community is lacking regarding how to combine these electromagnetic and fluid dynamic effects in a rigorous fashion to correctly satisfy the physics in complex situations that include chemical reactions and other complex laminar/turbulent or vortex flow effects. If these effects are real, MHD may be a more promising technology than previously considered.

This proposal requests a Postdoctoral Fellow to examine and document the above differences by reviewing additional open source literature that identifies contrarian results. The Postdoctoral Fellow should have applicable experience in MHD, numerical simulations, and scramjet flows with sufficient publications to demonstrate this expertise, in order to perform the following tasks:

- Identify foreign/U.S. differences in theoretical approaches or computational algorithms, and explain why certain physical terms are included or omitted in the conservation equations.
- Formulate conservation equations to more accurately predict these effects and then modify an existing or industrial standard software package (agreed upon before hand or to be provided). The final software will treat laminar/turbulent flows with chemical reactions and include Maxwell's equations within the formulation.
- Reproduce the Russian results using both their input electric and/or magnetic field values or altered values to match available test or numerical data.
- Generate and publish preliminary analysis/results in monthly reports to the contract monitor or mentor.
- Document the complete analysis in a final report, stating differences

uncovered in the algorithms and mathematical theory. Discuss the final theoretical development and the computer program development, to include providing a listing of the executable code (in the report and in electronic files). Show three sample cases (to be agreed upon with the task monitor) that match foreign data and document these sample cases (electronic files also will be provided to the Government of executable examples). Include recommendations that may minimize any future technical surprises in this or related disciplines.

- Present results at an appropriate forum, such as conferences sponsored by the American Institute of Aeronautics and Astronautics (AIAA).

8.11. Sensemaking: Improving the Shared Creation of Knowledge

POC: Dr. David Alberts, David.Alberts@osd..mil, 703-695-7183 (DIA)

Intelligence organizations have access to vast quantities of information gleaned from a variety of both internal and external sources. The challenge is one of developing a capability – through both individual and collaborative processes – to "make sense" of the situation. From an organizational perspective, the sensemaking process begins with developing and sharing awareness, continues with developing a deep understanding including identification of possible courses of action or responses and concludes with decisions. The ability of an organization to "make sense" of the situation depends not only on its information-related capabilities of collection, processing, and distribution -- properties in the physical and information domains -- but also upon its capabilities in the cognitive and social domains. Bringing a variety of perspectives and expertise to the job of sensemaking and accomplishing sensemaking in a collaborative environment are critical to the ability to deal with the unexpected and asymmetrical.

Measurement is critical to both sensemaking itself and to analyses and experiments designed to understand and improve sensemaking. One must be able to measure a hierarchy of sensemaking-related competencies at the individual, collaborative, and organizational levels. This starts with the development of situation awareness (the ability to identify key objects, events, and situations in the operating environment and to perceive extant patterns among them) and works through the full range of sensemaking-related activities. Of particular importance is the understanding of the development of shared awareness, knowledge, understanding, and decision-making. Sharing information, awareness and understanding requires collaborative processes and the development of trust among the participants. Trust is itself multidimensional. Intelligence analysts develop trust (or mistrust) in sources, the technologies they employ, in peers, superiors and subordinates, and in the tools of collaboration. Research needs to be done on how trust is developed as well as the "structure" of trust and relationships

involved in sensemaking. Research may include design and conduct of experiments to identify, isolate, and measure those factors that affect trust in digital networked organization.

Better tools (e.g. displays, agents, workspaces) should facilitate (or relieve humans of) the more tedious tasks of detailed information retrieval, monitoring, and basic processing. They should also facilitate collaboration that allows analysts to create a body of expertise capable of addressing multiple aspects of a problem and overcoming individual perceptual filters, cognitive biases, and other limitations. Tools for sensemaking in intelligence analysis will improve the process and free up time for analysts to do more analytical work. Intelligence analysis has traditionally been taught through apprenticeship and a series of short courses that develop specific skills. Integrative processes such as sensemaking are developed over time, most often as a result of individual initiative. Intelligence analysts need an approach to understanding the nature of sensemaking that enables them to see it in the context of their profession, and learn the social and cognitive skills involved.

8.12. Investigating Various Empirical and Linguistic Methods in Pursuit of Automated Analysis, Data Mining, Collaboration and Inference Processes

POC: Dr. Boyan Onyshikevych, baonysh@nsa.gov, 301-688-0303 (NSA)

A crucial step in the intelligence analysis process involves getting specific facts, knowledge elements, or "essential elements of information" from raw data. For open source news, technical documents, SIGINT, etc., this requires a human to perform that conversion function. For example, an analyst might read a newswire report and enter information about a new foreign leader into their knowledge base.

Previous R&D work at the various Intelligence Community agencies has involved focused efforts to automate portions of the analysis process through technologies such as information extraction, or to assist human intelligence analysts by making data easier to analyze through machine translation, information retrieval, or clustering.

The research being solicited here would concentrate on algorithms and methodologies for extracting knowledge from unstructured text in English and/or a foreign language, and explicitly structuring and representing that knowledge in a knowledge representation language. This research would fuse together several generally distinct lines of research: information extraction, semantic parsing, semantic web concepts and interlingual machine translation.

The postdoctoral researcher who would be pursuing this work would be expected

to have strong credentials in Natural Language Processing, whether from an Artificial Intelligence, Computational Linguistics, Information Theory, or other perspective. Familiarity with semantic parsing, information extraction, semantic web concepts, and/or interlingual machine translation would be expected.

8.13. Color Appearance Models and Improved Visual Analysis

POC: Mr. Bill Butterfield, 301-688-9280 (NSA)

Multi-sensor visual data is often presented to analysts on color electronic displays developed and calibrated to produce a pleasing image rather than one optimized for information extraction. Analyses may be based on a mismatch between these electronic systems and the human.

Recent research findings in human vision and color science have been incorporated in color appearance models of simple, but realistic, scenes.

Focused research is needed to study the potential benefit of more complex color appearance models on the accuracy of intelligence analyses and the speed of the decision--making process.

8.14. Separation, Functionalization, and Self-Assembly Chemistry of Carbon Nanotubes

POC: Dr. Vincent Ballarotto, 301-935-3147 (NSA)

Presently there is a strong interest in exploring chemical and physical approaches to creating a modular system of nano-devices that can be assembled to create a device. The potential for creating such nano-scale components for sensors with internal feedback and external accessibility is real. Thus, research needs to focus on the assembly of these nano-structures at the systems level. Self-assembly of nano-structures into quasi-periodic arrays is fairly common, but it only provides limited flexibility for systems development. Therefore, assembling nano-structures into a working configuration will require a different approach.

One approach to solving this assembly problem is to utilize biochemical linking schemes to direct self-assembly. Ideas are solicited that mimic the specific binding characteristic of biological systems to define the systems level organization. To achieve this objective for directed self-assembly of carbon nanotubes (CNT) two major problems need to be addressed: functionalization and separation of CNT. First, the CNT need to be functionalized to incorporate binding sites. Second, it is necessary to separate the CNT aggregate by electronic type (metallic or semi-conducting). In addition, separation of the

CNT by density (or size) is also necessary. Any process that can separate CNT by either electronic type or size would be a major breakthrough.

The insights gained from investigating each of these problems could be applied to the general problem of assembling systems of nano-structures that in turn could lead to the development of nano-scale biological and chemical sensors.

8.15. Earthquake Pre-cursor Propagation Model and Signal Analysis Techniques

POC: Dr. John Spencer, 703-808-4916 (NRO)

It is proposed that a Postdoctoral Fellow with geophysics background be utilized in the first year to investigate the propagation of RF signals from ground to space as a precursor to seismic activity. This would provide the groundwork of a potential link model of this unique RF phenomenology. This investigation would not only cover the propagation but also address any environmental effects that would modify the propagation.

Since 1985, researchers have published results showing that satellites in polar orbit have measured RF signals that were potentially generated by seismic activity. Research such as that of the Intercosmos-24 and –19 detected RF signals as earthquake precursors. In 1981, the French satellite, Aureol-3, also documented similar RF signals as earthquake precursors. The Russians repeated their study in January 1989 with Cosmos-1809, which measured Armenia precursor activity as RF signals. At present there are three geophysical satellites in orbit: CHAMP, Orsted 1 and Orsted-2. These satellites are being used to investigate the propagation of seismic activity into space.

In 1996, H. C. Koons investigated the propagation of seismic activity into space. But he did not address such effects as space weather, magnetosphere or ionosphere. The propagation through the ionosphere, or any other space weather influence, can potentially act as a filter, or refractor, of such RF signals.

NRO's interest in this area is in support of future satellite technology. Such an investigation could potentially be used to improve existing RF link models. Such an understanding could improve frequency management and geo-positioning.

The results of the first year study could potentially identify specific areas in the link model that would justify a second year research effort. As such, the candidate maybe requested to continue this investigation for a second year.

8.16. Nano-Electromechanical systems (NEMS) for Advanced Sensor Concepts

POC: Dr. Frank D. Gac, 703-874-0834 (ITIC)

The Intelligence Community (IC) has embarked on the creation of an IC Nano-ENABLED-technology Initiative. One important technology thrust that has been identified for this initiative is advanced sensor concepts. This topic, however, encompasses a very broad range of approaches and applications. The purpose of the proposed postdoctoral research topic is to refine the scope to focus on advanced sensor concepts, based on the development of nano-electromechanical systems (NEMS). At this point, even the development of micro-electromechanical systems (MEMS) is in its infancy. Thus, NEMS represent a long-term desire, not a near term reality.

Such a topic is ideal for engaging a bright, new postdoctoral researcher in IC interests. It offers the candidate the opportunity to become involved in true cutting edge, high-risk research. High and risk are the operative words because the candidate will have to be extremely productive and creative to make significant, pertinent accomplishments in a 1-2 year period of time.

To improve the chances of success for this endeavor, the following criteria must be satisfied. First, the research institution and selected technical staff should already possess considerable experience in advanced sensor development. Second, the institution should be equipped with the facilities to produce and characterize MEMS. Finally, the institution should have an ongoing, extensive effort in nano-science research to provide an environment where creative, new ideas in nano-science, engineering and technology can be conceived and pursued.

8.17. Bio-Nano Electronic Circuitry

POC: Dr. John R. Philips, 703-874-0814 (ITIC)

The intersection of biological- and nano-science offers exciting opportunities for doing things that have never been contemplated before. Of particular interest to the Intelligence Community is the vast arena of electronic circuitry, be it for communications, encryption, computation, and so forth. The combination of biological science with nanotechnology concepts offers the potential to produce a new class of electronic circuitry that rivals the complexity and capacity of a human neuro-system.

The objective of the proposed research topic on bio-nano electronic circuitry is to provide a venue whereby novel, new ideas and concepts might be explored. Molecular electronics could serve as a starting point for the research. However, it is desired that the

postdoctoral research candidate proposes and explores creative new approaches for constructing and using bio-nano electronic circuits.

To improve the chances of success for this endeavor, the following criteria must be satisfied. First, the postdoctoral research candidate should possess considerable experience in the biological and engineering sciences. Second, the research institution should have an ongoing, extensive effort in nano-science research to provide an environment where creative, new ideas in nano-science, engineering and technology can be conceived and pursued. Finally, the research institution must possess a history of effective research interactions between the biological and engineering disciplines of the institution.

8.18. Multi-User Detection: Algorithm Evaluation

POC: Dr. George DuMais, 703-874-3293 (ITIC)

A great deal of research has gone into the development of multi-user detection (MUD) algorithms since the seminal work of Sergio Verdu in 1984. An extensive listing of MUD literature can be found in Verdu's 1998 textbook Multi-user Detection2. With the advent of third-generation (3G) wireless technology, MUD technology is receiving much more attention in the research literature - this time from a practical engineering perspective rather than a theoretical one. Many of the new 3G systems are characterized by a wideband CDMA signal and co-channel signals are inherent in Code Division Multiple Access (CDMA). The question is, “Can MUD techniques provide cost-effective solutions to the problem demodulation of co-channel CDMA cellular signals?” This is a crucial issue for the future processing of wireless data.

Complicating the already difficult problems are the underlying assumptions of various MUD algorithms and how they relate to typical signal processing situations. “Blind” signal reception and processing typically means that the receiver has no knowledge of the specific data content, but does know the general statistical characteristics of the co-channel signals. “Semi-blind” typically means a receiver can take advantage of some underlying data content, usually invariant data fields such as framing bits or training sequences. In CDMA, the receiver usually knows at least the spreading sequence (signature waveform) of the signal of interest and may know the signature waveform of the interfering co-channel users.

While many papers describe a variety of MUD algorithms, the literature comparing the performance and engineering tradeoffs of various algorithms is sparse. The objective of this research effort is to evaluate the leading blind and semi-blind algorithms for processing wideband CDMA signals defined by the 3G version of the International Telecommunications Union’s (ITU's) IMT-DS standard.

8.19. Smart Materials for Components of Mobile Robots

POC: Dr. Gregory Moore, 703-874-0831 (ITIC)

Many technologies have been developed in support of mobile robotics over the past few years, including improved means of locomotion, energy storage, navigation, decision-making, vision, and obstacle avoidance. These advances have brought the field to the brink of some truly useful "taskable" machines.

Some of these advances have been bio-inspired; for example, the recent advances in legged platforms are one example. Most would agree, however, that a quick comparison of a cricket leg and a leg developed for a mobile robot shows vast (and somewhat humbling) differences in the complexity of the sensing and actuation, the processing, and the energy generation and distribution. To a great extent, one can think of such natural systems as very sophisticated smart structures.

We are interested in proposals that provide insights in two areas. First is a better understanding what practical advantages accrue from such higher degrees of complexity, and second are demonstrations of the extent to which those advantages can be realized in robot components such as legs, antennae, and surfaces that a robot could use for sensing and negotiating, unstructured terrain. We anticipate that many of the principles and practices in the field of smart structures and rapid prototyping will apply to this problem.

8.20. Terahertz Imaging

POC: Dr. Martin Carr, 703-874-2531 (ITIC)

The region of the electromagnetic spectrum from approximately 500 Gigahertz to 100 Terahertz is becoming better understood, as research into sources of radiation and improved methods of detection emerge in this frequency range. For the Intelligence Community, these breakthroughs represent both opportunities and threats. For example, the new terahertz imaging technologies may provide new and more reliable ways to search mail and other packages for threatening materials. Alternatively, such technologies may reveal something that we intended to remain hidden. We seek proposals that will help us to understand the limits of this technology. Possible topics include novel sources, detection methods, and understanding the interactions of materials at terahertz frequencies (propagation, exploitable resonances or other signatures in the terahertz range, etc.).

8.21. Probabilistic Evidence Marshalling

POC: Dr. Susan Durham, 703-874-4264 (NRO)

Previous research has demonstrated the capability to use software agents coupled with multiple statements of fact (clues) to discover interesting, nonintuitive patterns that support solving a particular problem. Examples have included solving fictional crimes, as well as the well-known Einstein (or 5-Houses) Problem. However, the utility of these efforts has been limited because of a necessary assumption that the clues be accepted as completely true. The proposed new research should address the more general problem where each of the clues is not a statement of fact but, rather, is simply a hypothesis with an associated level of confidence, thereby investigating ways to expand on the current complexity science-based technology known as agent-based evidence marshalling. Such an extension would make agent-based evidence marshalling much more applicable to real-world analysis problems.

To accomplish this proposed research requires investigating applications and literature in complexity science, evidence marshalling, and applied probability theory, e.g., Bayesian Networks, Directed Graphs, etc. Proposed tasks include research and critique academic and commercial methodologies that apply to evidence marshalling technologies used by individuals, teams, and organizations; identifying key open questions and possible areas for adjunct research; and documenting findings in a detailed, fully referenced final report.

8.22. Improving the Security of Future Biometric Systems

POC: Dr Andy Kirby, 703-874-1023 (ITIC)

Biometrics-based authentication systems (BAS) are being implemented at an increasing rate in Government and industry for many different security applications such as authentication and/or identification. However, like traditional password-based authentication systems (PAS), biometrics-based authentication systems must be designed to withstand a variety of possible attacks, particularly when they are implemented in high-security applications. In addition, unlike PAS, BAS present privacy issues that demand that additional steps be taken to prevent the compromise and potential abuse of a person's unique identifiers.

In their recent paper examining the security and privacy issues associated with biometrics, Ratha et al of IBM describe eight potential vulnerabilities common to a generic biometric system [1]. These can be summarized as 1] presenting a false biometric source, 2] replaying the biometric of another enrollee, 3] inserting a false feature extraction, 4] tampering with the feature representation, 5] tampering with the matching algorithm, 6] altering the stored feature templates, 7] attacking the communications channel between stored templates and the matching engine, 8] disabling the authentication system by overriding its final decision. In addition, Schneier has described potential abuses of biometric systems including the vulnerability of personal

data to theft and the illicit use of someone else's biometric.

The primary objectives of this research topic are:

1. Examine the key vulnerabilities unique to biometric systems from two different perspectives: security compromise due to overall system attack and due to identifier exposure and misuse.

2. Examine recently proposed models for eliminating these vulnerabilities, and propose new or additional models as appropriate.

3. Demonstrate successful implementations of the most promising models for eliminating key vulnerabilities in a laboratory environment.

4. This research project may involve an exploration into various types of biometric systems, including their basic architectures, hardware, and software. However, its fundamental goal is to better secure future biometric systems from intrusion, misuse, and loss of personal identifiers.

[1] "Enhancing Security and Privacy in Biometrics-Based Authentication Systems," N. K. Ratha, J. H. Connell, and R. M. Bolle, *IBM Systems Journal*, Vol. 40, No. 3, 2001.

[2] "The Uses and Abuses of Biometrics," Bruce Schneier, *Communications of the ACM*, Vol. 42, No. 8, August 1999.

9. SIGNIFICANT DATES

The following table provides the significant dates referred to in the body of this announcement.

Action	**Responsibility**	**Due Date**
Issue announcement	Government	27 FEB 2003
Proposal due	Principal Investigator	26 MAR 2003
Acknowledge receipt of proposals	Government	28 MAR 2003
Letter of intent to recommend for award	Government	28 APR 2003
Estimated Start date	Principal Investigator	30 MAY 2003
DCI Postdoctoral Colloquium (required attendance)	Government	5-7 MAY 2004

9.1. Late Submissions

Proposals will be considered for award if submitted timely. If a proposal is submitted in an untimely manner, after 3:00 P.M. (Eastern Daylight Savings Time) on, 26 March 2003 the criteria in Federal Acquisition Regulation part 15.208 will be adhered.

POINTS OF CONTACT

9.2. Grants and Contracting

Ms. Jo Ann Moore at 703 735-3122.

9.3. Technical Issues

Mr. Stephen Malys at 301-227-7452.